Analysis of High Response Times to Wildfires

By Tom W. Patton
Piedmont Regional Forester
South Carolina Forestry Commission
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The South Carolina Forestry Commission (SCFC) was established in 1927 to "... *take such action and afford such organized means as may be necessary to prevent, control and extinguish fires....*" During its eighty years, the agency has grown from an initial workforce of less than a dozen men with very little equipment to its current fire suppression organization of 205 firefighters with heavy equipment (tractor plow units, see picture 1 in Appendix A), pickup trucks with water handling capabilities, and hand line equipment. The SCFC's fire suppression strategy is to control wildfires during initial attack, using tractor plow units, while fires are small, before they grow in size to the point that additional, scarce resources are required for extended operational period(s). Controlling fires while they are small results in less acreage burned, reduced risk to life, less damage to property, and fewer resources required.

Currently, the standby stations for the tractor plow units, which consist of a transport truck, bladed bull dozer (tractor) with a fire plow (see picture 2 in Appendix A), are at the operators' residences/farm/businesses; therefore, units are dispersed throughout a county rather than at a central work station serving multiple counties (see Appendix B for map of standby locations). In the past this system of standby locations has resulted in low response times, which is a critical function of the initial attack strategy. **The average response time for the initial attack warden/firefighter is a performance measure in the Forestry Commission's Accountability Report.** The agency's goal is an average response time of 30 minutes or less.

Description of Problem

The number and distribution of tractor plow units/resources has changed over the years due to budget cuts and new regulations (commercial driver licenses, drug testing, physical fitness standards, etc.) resulting in a reduction of the available workforce. There are currently 150 tractor plow units (initial attack resources) available to respond to wildfires, down from a high of 229 in 1983. Under current labor regulations, on any given day, one-third of this workforce could be off duty. This reduction in the actual workforce and the reduced number of those operators available to be on duty has resulted in fewer available resources covering greater area and traveling farther distances. This has the potential of increasing response times, especially during a severe fire season. As response times increase the amount of acreage burned, property damaged/destroyed, and chance of injury/deaths increases. Therefore, the purpose of this project was to analyze response times of 40 minutes or more, to determine which factor(s) are contributing to excessive response times.

Response Time

Response Time (RT) is calculated from time when dispatch is notified of a wildfire to the arrival of the first tractor plow unit at the fire. RT can be separated into different phases, all of which are affected by numerous variables. For this project RT is separated into the four phases listed below:

1) Dispatching – time between initial report of wildfire and first attempt to contact initial attack resource. Dispatch receives notification of wildfires from aerial detection aircraft, emergency response agencies (fire departments, sheriff, highway patrol, etc.), and the public, especially since the introduction of the 911 system and cell phones. Once the

location has been determined CADS, the Computer Aided Dispatch System, automatically recommends the closest available unit to contact.

2) Contact Established – time between first attempt to contact initial attack unit/resource and when contact was established. Once a unit to contact has been selected, a page is automatically sent to the operator. Sometimes the page does not go through. Dispatch will also try to establish contact by phone and/or radio during the first five minutes. If contact has not been established within the first five minutes, Dispatch has the option to contact the next closest unit.
3) Time to Enroute – time between contact established with initial attack unit/resource and enroute time. Once contact has been established the operator has a 10 minute goal to be enroute. Times to enroute can be long if the operator is not close to the unit and/or forgets to notify dispatch that he/she is enroute.
4) Travel (enroute/rolling) – time between going enroute and arriving at wildfire. There are at least seven variables that affect travel time. They are 1) distance to travel, 2) closer units off duty, 3) closer units dispatched to another fire, 4) originally closer units on non-emergency dispatch (at meetings, trainings, conducting prescribed burns, constructing firebreaks, etc) at location farther from the fire than their standby location, 5) traffic congestion, 6) not being able to locate fire and 7) closer units on duty but not in CADS as available.

Table 1 shows a summary and comparison of the four phases of response times from 1999 to 2006. This table also shows the average for the seven year period from 1999 through 2005 for comparison to 2006. Why? Because in 2006 the computer aided dispatch system (CADS) was updated which resulted in improved operating efficiency especially in certain phases which

provided an improved automatic paging function and more accurate information in selecting the closest available unit/resource. The new system also provides more reliable time information and more accurate documentation for each of the phases. For further explanation of why see notes in Appendix C.

Table 1. Summary and Comparison of Response Times for Fiscal Year 1999 through 2006

TIMES	FY 99 Avg (Min)	FY 00 Avg (Min)	FY 01 Avg (Min)	FY 02 Avg (Min)	FY 03 Avg (Min)	FY 04 Avg (Min)	FY 05 Avg (Min)	FY 99-05 Avg (Min)	FY 06 Avg (Min)
Dispatching	6.11	5.68	5.42	6.27	5.12	5.10	6.33	5.72	4.18
Contact Establish	4.39	4.14	4.00	3.09	4.15	4.18	3.83	3.97	4.47
Enroute	8.32	8.40	7.72	6.06	7.92	7.95	7.10	7.64	8.44
Travel	24.48	23.60	23.03	22.60	22.49	22.39	22.11	22.96	20.09
Response	36.92	35.05	34.40	34.80	35.70	33.57	35.19	35.09	32.45

Data Analyzed

Data was analyzed for the one complete fiscal year (July 1, 2005 to June 30, 2006) that the new CADS system has been operational, since it provides more reliable data. Also, the improved functions of the new system reduced the time of some phases making it impossible to compare data from previous years. The following information from CADS was used to conduct the analysis:

- Listing of the response times for initial attack unit to determine which wildfires had response times of 40 minutes or more.
- Maps (in Appendix D, E and F) showing location of all units and fires during each of the 20 day fire activity categories to determine if other units were closer than the unit dispatched.

- Data listing the fire attendance of every unit to determine if a closer unit was already dispatched to another fire and, therefore, not available.
- Data indicating duty status (on or off) to determine if closer units were off duty and, therefore, not available.
- Data to determine if closer units on a non-emergency dispatch were either not available for emergency dispatch or at a location resulting in it no longer being the closer unit.
- Data to determine if unit sent was responding from a location different from its standby location, which would result in a longer time to enroute and/or travel time. For example, unit could have been at a multi-unit fire, work detail, meeting, etc, and was dispatched from a location that was farther away than its standby location or the process of returning the tractor back to and loading on transport took more than ten minutes.
- Data to determine if units were on duty and not listed in CADS as available or off duty and listed as available in CADS.
- Data showing the readiness level, which dictates staffing levels and allowable work activities, especially for days with high fire occurrence.

All this data was checked for each wildfire that was included in the analysis.

Analysis

In FY 2006 there were 3,020 wildfires (see Appendix G for map showing fire locations) in South Carolina and the average statewide response time was 32.45 minutes, with 50.2% of all wildfires having a response time greater than the agency's goal of 30 minutes or less. Eight

hundred, forty-eight wildfires or 28.1% of all wildfires had a response time of 40 minutes or greater. It is a known fact that excessively high response times occur on days with high fire occurrence when there are more fires than resources available to response. What is not known is

1) do high response times occur mainly during periods of high fire activity rather than days with low or moderate fire activity and
2) which variables have the most impact on and offer the most opportunity to reduce high response times?

In order to determine the answer to item 1, the 20 lowest fire activity days, the 20 average fire activity days and the 20 highest fire activity days were examined to determine the number and percentage of fires in each category that had response time of 40 minutes or more. There were 41 days in the Lowest Fire Activity category – which were days with only one fire per day. A random number generator was used to select the 20 sample days, which provided 20 fires to review for this category. Ten fires per day was the average fire occurrence for the 2005-06 fire season. The 20 sample days for the Average Fire Activity category were selected by taking the 10 days below and above the mean fire occurrence, which ranged from 9 to 11 fires per day, which provided 199 fires to be reviewed. The 20 sample days for the High Fire Activity category were selected by taking the 20 days with the highest fire occurrence, which ranged from 34 to 64 fires per day, which provided 867 fires to be reviewed.

As shown below in Table 2 the results indicate that high response times occur through out the year and not just during periods of high fire activity. In fact, percent of high RT was greatest at 30.0% (6 out of 20 fires) for the lowest fire activity category, 26.9% (233 out of 867 fires) for the highest fire activity category and lowest at 24.1% (44 out of 199 fires) for the average fire activity category.

Table 2. Percent of Fires with Response Times of 40 Minutes or More for Low, Average and High Fire Activity Days.

FIRE DAYS	# of Fires	# fires w/ RT > 40 min+	% of fires w/ RT of 40 min+
20 Lowest	20	6	30.0%
20 Average	199	44	24.1%
20 Highest	867	233	26.9%

Therefore, in order to determine the answer to item 2, it was necessary to analyze each fire activity category to determine which factors were contributing the most to high response times. All the fires in the low and average fire activity category with high RT were analyzed. Due to the large number of high RT fires (233) in the high fire activity category, only a third were analyzed. In order to provide a uniform sample throughout the range of high RT in the high fire activity category, the fires were sorted from lowest to highest RT and then every third fire was selected.

Results

Results for each individual category are discussed and listed below in Tables 3, 4 and 5.

Lowest Fire Activity: The number of fires in this category with high RT was six out of twenty, which was 30.0% of all fires in this category, and resulted in this category having the highest percentage of high RT. The high RT ranged from 40.07 minutes to 94.50 minutes. Listed below in Table 3 are the five factors that contributed to the high RT for this category.

Table 3. Results for 20 Lowest Fire Activity Days.

Reason for RT of 40 minutes+	# of Fires	% of Fires
High Dispatch Time	1	16.7%
Long Travel distance	2	33.3%
Higher than expected travel time	1	16.7%
High contact time & closer unit not dispatched	1	16.7%
Combination of all phases of response	1	16.7%
Total	6	100.1%

Average Fire Activity: The number of fires with high RT was 44 out of 199, which was 24.1% of all fires is this category. The high RT ranged from 40.13 minutes to 82.95 minutes. Listed below in Table 4 are the ten factors that contributed to the high RT for this category.

Table 4. Results for 20 Average Fire Activity Days.

Reason for RT of 40 minutes+	# of Fires	% of Fires
High Dispatch Time	4	9.1%
Long Travel distance for closest unit dispatched	2	4.5%
Closer unit(s) were off duty	7	15.9%
Closer on duty unit(s) on non-emergency dispatch	3	6.8%
Traffic congestion	8	18.2%
Higher than expected travel time	3	6.8%
High contact time for closest unit dispatched	1	2.3%
High contact time & closer unit not dispatched	2	4.5%
High time to enroute	1	2.3%
Combination of all phases of response	13	29.5%
Total	44	100.0%

High Fire Activity: The number of fires with high RT was 233 out of 867, which was 26.9% of all fires is this category. The high RT ranged from 40.15 minutes to 104.12 minutes. Listed below in Table 4 are the thirteen factors that contributed to the high RT for this category.

Table 5. Results for 20 High Fire Activity Days.

Reason for RT of 40 minutes+	# of Fires	% of Fires
High Dispatch Time	5	7.1%
Long Travel distance for closest unit dispatched	1	1.4%
Closer unit(s) were off duty	7	10.0%
Closer units on duty but not in CADS as available	7	10.0%
Closer on duty unit(s) on emergency dispatch	14	20.0%
Closer on duty unit(s) on non-emergency dispatch	4	5.7%
Traffic congestion	5	7.1%
Higher than expected travel time	7	10.0%
High contact time for closest unit dispatched	4	5.7%
High contact time & closer unit not dispatched	3	4.3%
High time to enroute	1	1.4%
Combination of 2 groupings of phases	12	17.1%
Total	70	100.0%

Conclusions and Recommendations

Thirteen factors were identified that could result in high response times (RT). As mentioned in the results section, five factors caused high RT in the Low Fire Activity (LFA) category, ten factors caused high RT in the Average Fire Activity (AFA) category and all thirteen factors caused high RT in the High Fire Activity (HFA) category. Results for all phases of RT and factors affecting RT for all three categories are listed below in Tables 6.

Table 6. Factors Affecting Response Times

	20 Low Days		20 Avg Days		20 High Days		Wt Avg
RESPONSE TIME PHASES & FACTORS	**#**	**%**	**#**	**%**	**#**	**%**	**%**
Dispatch Time	**1**	**16.7**	**4**	**9.1**	**5**	**7.1**	**8.3**
High Contact Time							
Unit sent was closest	0	0.0	1	2.3	4	5.7	**4.2**
Closer units available but not sent	1	16.7	2	4.5	3	4.3	**5.0**
sub-total	**1**	**16.7**	**3**	**6.8**	**7**	**10.0**	**9.2**
Enroute Time	**0**	**0.0**	**1**	**2.3**	**1**	**1.4**	**1.7**
High Travel Time to Fire due to:							
Distance from Unit sent							
Unit sent was closest	2	33.3	2	4.5	1	1.4	**4.2**
Closer units were OFF Duty	0	0.0	7	15.9	7	10.0	**11.7**
Closer units on duty, not in CADS as available	0	0.0	0	0.0	7	10.0	**5.8**
Closer units were on Emergency Dispatch	0	0.0	0	0.0	14	20.0	**11.7**
Closer unit on Non-emergency Dispatch	0	0.0	3	6.8	4	5.7	**5.8**
Traffic congestion	0	0.0	8	18.2	5	7.1	**10.8**
Travel time high	1	16.7	3	6.8	7	10.0	**9.2**
sub-total	**3**	**50.0**	**23**	**52.3**	**45**	**64.3**	**59.2**
Combination of Phases							
Contact, enroute and/or travel times	0	0.0	7	15.9	10	14.3	**14.2**
Dispatch, contact, enroute and/or travel times	1	16.7	6	13.6	2	2.9	**7.5**
sub-total	**1**	**16.7**	**13**	**29.5**	**12**	**17.1**	**21.7**
Total of all Phases	***6***	***100***	***44***	***100***	***70***	***100***	***100***

Each phase/factor will be discussed below.

1) High Dispatch Time resulted in high RT in all three fire activity categories (16.7% for LFA, 9.1% for AFA and 7.1 % for HFA periods). The weighted average for all categories was 8.3%. The one factor that can greatly affect dispatch time is the time it can take to determine the location of fires reported by the public because of incorrect and/or incomplete information, which the Dispatch Center has no control over.

Recommendations: Monitor.

2 & 3) High Contact Time accounted for 9.2% (16.7% in LFA, 6.8% in AFA and 10.0% HFA periods) of high RT. High contact time can be separated into either – 1) high contact time when unit sent was closest, or 2) high contact time when closer units were available but not sent. Once the Dispatch Center determines which unit to dispatch, a page is sent to make contact and is followed up by calling the unit by radio and/or telephone in case the page didn't do through. After five minutes, the Dispatch Center can either continue to attempt to make contact or try to contact another unit.

Recommendations: Monitor. Eventually when work stations, which are a permanent location which on duty operators would use as their standby location, are established the problem of high contact times should be all but eliminated. In fact, the average time to contact should be less than one minute, which will be significantly less than the average time of 4.47 minutes for FY 2006.

4) Time to enroute, also referred to as enroute time, accounted for 1.7% (2.3% for AFA and 1.4% for HFA periods) of high RT. Times to enroute can be long if the operator is not close to the unit and/or forgets to notify Dispatch that the unit is enroute.

Recommendations: Monitor.

5-11) High Travel Times to Fires accounted for 59.2% (50.0% for LFA, 52.3% for AFA and 64.3% for HFA periods) of high RT. There are seven factors that could affect travel times and are separated into 3 groups – A) travel distance of unit dispatched, B) traffic congestion and C) travel time high for route.

A. Travel Distance of unit dispatched – five of the seven factors affecting travel time dealt with travel distance.

5. **Dispatched unit was closest to fire** and accounted for 4.2% of high RT (33.3% in LFA, 4.5% in AFA and 1.4% in HFA periods). One way to mitigate the effect of this factor would be to pre-position units to areas with historic high fire occurrence that are far distances from unit standby locations. The SCFC does pre-position units and the fact that only 1.4% of the high RT during HFA is due to travel distance indicates that pre-positioning of units is working.

   Recommendations: Monitor.

6. **Closer units were off duty** accounted for 11.7% of high RT. Due to regular days off and annual leave, on certain days available units have greater areas to cover and distances to travel. For this reason it would be expected that off duty units would cause high RT, but the data didn't show this for LFA - possibly due to the small sample size. As expected, it did cause high RT during AFA, accounting for 15.9% of high RT. The data also showed 10.0% of high RT during HFA resulted from units being off duty. During periods of AFA, this rate may be reduced by scheduling off duty of units to try to ensure uniform distribution of available units. During HFA a high readiness level should be set in accordance with the fire suppression readiness plan procedure to ensure all personnel are either on

duty or on call, except for emergency leave. It is important to note that readiness is set based on the best estimate of the projected fire situation and is only a prediction. Data shows that most of the high RT that occurred during periods of HFA happened on days the readiness level was set at moderate rather than high. Scheduling off duty for units is permitted during a moderate readiness level. Fire Staff and Region personnel are in the process of reviewing the readiness level procedure and application with the aim of improving consistency in determining readiness levels.

Recommendations: Closer scrutiny on off duty schedule during AFA periods. Continue the analysis of HFA that has been undertaken to determine if there are measurable variables that would help better predict periods of HFA and thus improve the setting of readiness levels.

7. **Closer unit on duty but not in CADS as available for dispatch** accounted for 10% of all high RT. All of which occurred during the period of HFA.

   Recommendations: Review of procedures is needed to ensure that this situation does not continue.

8. **Closer units on emergency dispatch** resulted in 20.0% of high RT. Data shows this was only a factor during HFA and not during LFA and/or AFA. Re-positioning of resources by shifting units from areas of LFA to back fill areas where no units are available due to HFA might mitigate this situation; however, this is a risky strategy since fire occurrence can change and what was a LFA area could become a HFA area. The reduced number of tractor plow units is a major factor in this high RT rate.

Recommendations: The number of tractor plow units and operators needs to be increased.

9. **Closer units were on non-emergency dispatch.** Non-emergency dispatch includes units being assigned to meetings/training, work details, services work (prescribe burning, plowing fire breaks, etc.) and accounts for 5.8% (6.8% for AFA and 5.7% for HFA periods) of high RT. Since training, work details and services work are activities performed by the SCFC, there is little opportunity to mitigate this factor during periods of LFA. Closer scrutiny of activities and distribution of available units during AFA might reduce some of the high RT. Data shows that most of the high RT that occurred during periods of HFA happened on days the readiness level was set at moderate rather than high.

   Recommendations: Continue the analysis of HFA that has been undertaken to determine if there are measurable variables that would help better predict periods of HFA and thus improve the setting of readiness levels.

B) **Traffic Congestion (10)** accounted for 10.8% (18.2% for AFA and 7.1% for HFA periods) of high RT. As the population and urbanization increase this factor will account for a greater percentage of high RT in the future. Pre-positioning may help but how much is uncertain.

   Recommendations: Monitor.

C) **Travel time high for route taken (11)** accounted for 9.2% (16.7% in LFA, 6.8% in AFA and 10.0% in HFA periods) of high RT, which is usually caused by the operator having difficulty locating the fire or locating access to the fire.

   Recommendations: Monitor.

12 & 13) Combination of all phases and factors of response time accounted for 21.7% (16.7 for LFA, 29.5% for AFA and 17.1% for HFA periods) of high RT. This phase can be separated into either 1) contact, enroute and/or travel times, which accounted for 14.2 % of high RT, and/or 2) dispatch, contact, enroute and/or travel times, which accounted for 7.5% of high RT. When no one factor could be determined to cause a RT of 40 minutes or greater it was reported in this category. High RT in this category occurred when two or more factors resulted in a high RT.

Recommendations: Monitor.

Low response time is an important component of the SCFC strategy to control wildfires while they are small; which results in less acreage burned, reduced risk to life, and less damage to property. This study of factors affecting high response times determined the following four possible opportunities for improvement: 1) review off duty schedule to ensure uniform distribution of available units when possible, 2) ensure that all units on duty are in CADS as available for dispatch, 3) increase the number of tractor plow units and operators, and 4) continue with analysis being conducted to determine if there are measurable variables that could predict periods of high fire activity in order to better set readiness levels, which dictates duty schedules and permissible activities. As conditions, such as staffing levels, population, road access, etc., change the SCFC should continue to review the factors that affect response times in order to ensure the goal of an average response time of 30 minutes or less is met.

REFERENCES and SOURCES of DATA

Act of General Assembly, Title 48 – Chapter 23 – Section 90; General Duties of Commission

Baumann, Jeff. Impact of Work Centers on Wildfire Response Times, January, 2003.

Data compiled from CADS for FY 2006.

Maps generated from CADS for FY 2006.

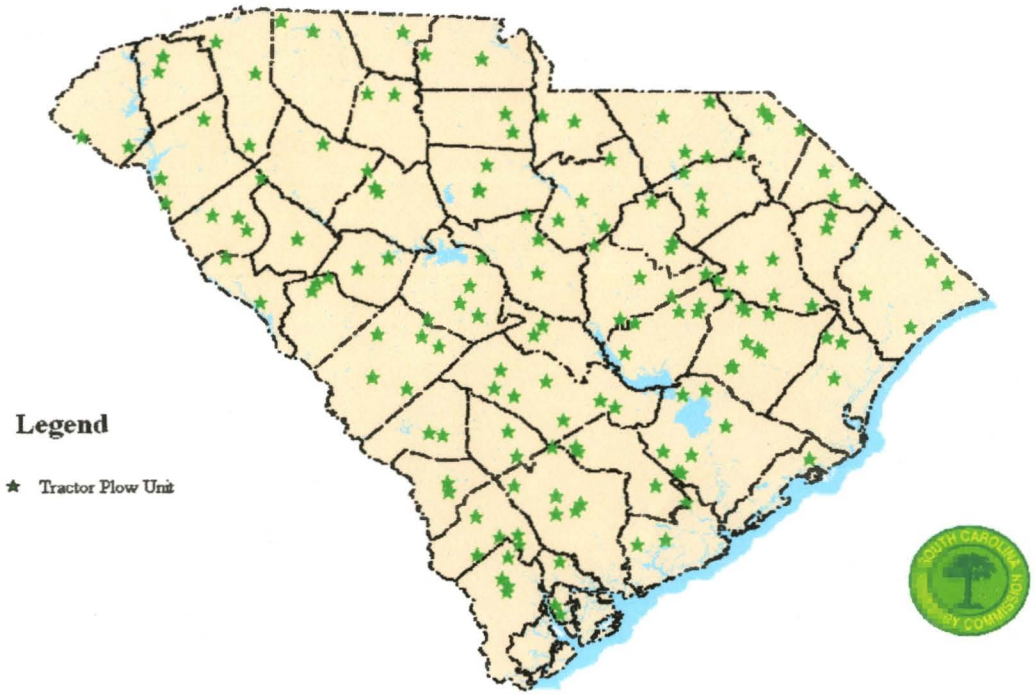
APPENDIX A

Picture 1. Tractor plow unit

Picture 2. Transport and tractor plow unit

APPENDIX B

Location of Tractor Plow Units
Fiscal Year 2006



APPENDIX C

CADS Notes

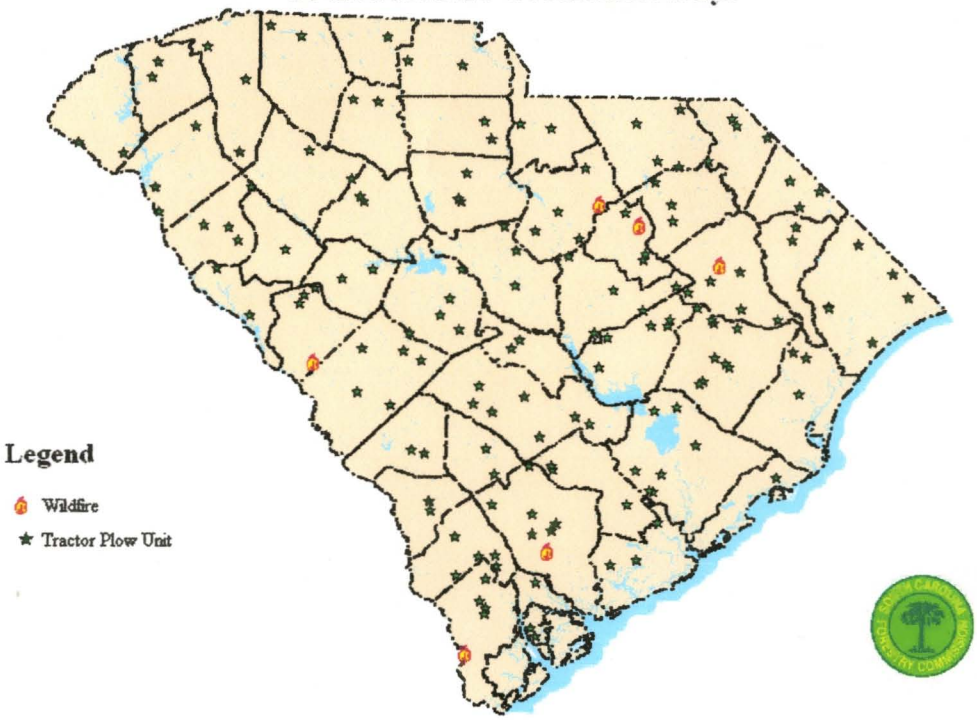
The new computer aided dispatch system (CADS) provides more reliable times since some key events are automatically time stamped by the system. With the old dispatch system, dispatchers manually time stamped events like contact attempts. This could account for some of the differences in Dispatching, Contact Established, and Rolling times from FY05 and FY06 which are calculated using the contact attempt times. The new system also has alarms that would notify dispatchers if certain time limits passed with no activity. This prompts the dispatcher to follow up with the warden on their status and improves data collection. In past years, it was necessary to discard hundreds of fires due to questionable times as wardens wouldn't notify dispatch when they went enroute or arrived on the fire. Only 14 fires discarded from FY06 data due to questionable times

The 2.15 minute improvement in dispatching time between FY05 and FY06 (when call was received to first contact attempt with IA Warden) can be attributed to the new dispatch system's improved closest available resources functionality and automatic paging of IA Warden. The old system could take a minute or longer to calculate the closest available resource and the dispatcher had to manually create and send the initial fire pages.

Improvement in travel time could be due to the new computer aided dispatch system or a change in the number or location of wardens. The new system may be doing a better job of selecting the closest available resource; capturing better time data; or both. A more in-depth analysis would be needed to identify the reason(s) for this decrease.

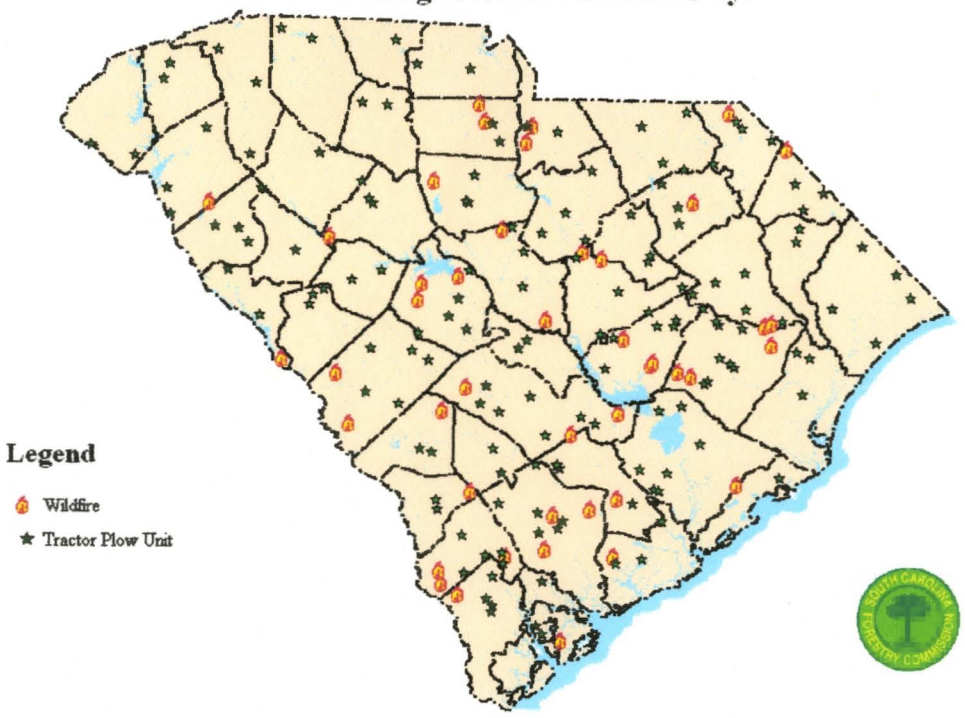
APPENDIX D

Wildfires with Response Times of 40 Minutes or Greater on 20 Lowest Fire Occurrence Days



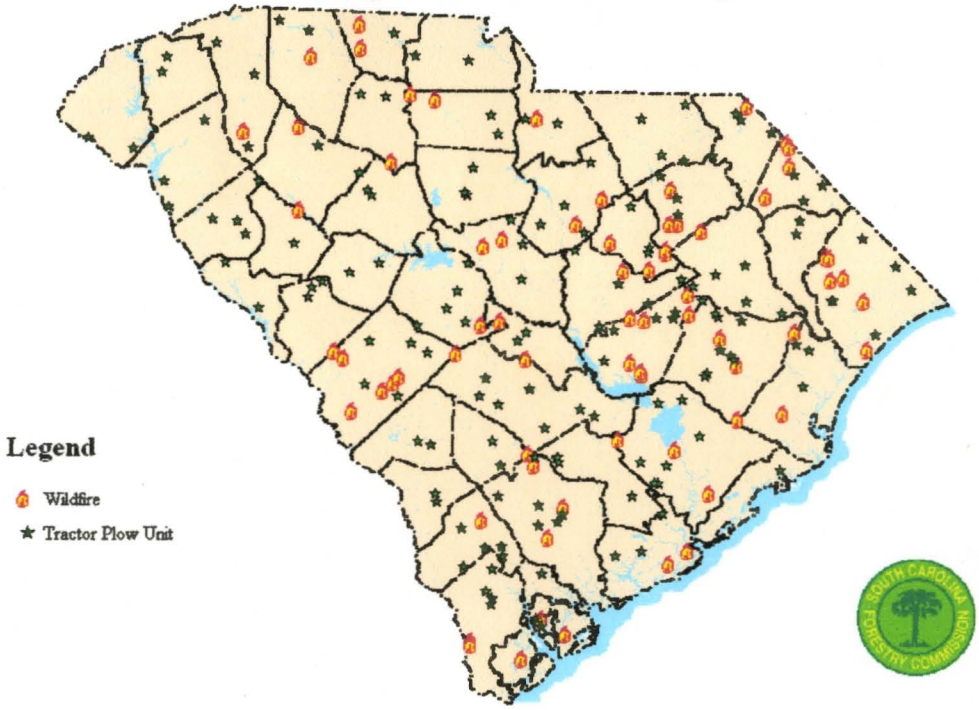
APPENDIX E

Wildfires with Response Times of 40 Minutes or Greater on 20 Average Fire Occurrence Days



APPENDIX F

Wildfires with Response Times of 40 Minutes or Greater on 20 Highest Fire Occurrence Days



APPENDIX G

Wildfire Occurrence
Fiscal Year 2006